# The Science Teacher

(See Page 4) *Courtesy Mabel Spencer*




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# The Science Teacher

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## A Study of Insects Affecting the Home

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**The possibilities in functional biology closely related to the individual's environment is indicated in the field of insect study. Other articles of a similar practical nature by recognized authors are planned for later issues.—Editor.**

MANY HIGH SCHOOL teachers of biology include in their course a unit on insects during the fall season. Thereafter, in many cases, insect instruction ceases and students are unaware of insect life during winter and spring. Modern biology teaching includes a study of insects throughout the school year and in such a practical way that the information achieved is closely associated with everyday living.

The fall study of insects in many cases centers about class collection and identification of the more common insects of a given community along with their economic bearing upon man. Following the fall studies, the teacher may well spend at least a small portion of the winter season upon the insects and related animals affecting the home. This study need not be lenghty or time consuming. If properly planned it can be a very valuable follow-up of the fall studies of insects.

The high school biology of today is readily weeding out the tiresome, time consuming individual morphological dissections and the laborious laboratory drawings which have occupied so much time of the high school course of the past and for which great apology is now offered. This antiquated biology of yesterday is being rapidly replaced with a more vital, dynamic biology wherein interest activities and discussions are promoted which stress the economic phase of biology and their applications to modern healthful, enjoyable and efficient modes of living.

IT IS THE PURPOSE of this paper to cast a little enlightenment upon the possibilities which justify the inclusion of insects affecting the home in modern biology courses. The inexperienced teacher very often fails to teach anything about insects during the winter season on the plea that there are no insects available during the cold months. What a revelation it must be to that teacher when it is known that at least several dozen different species of live insects may be captured in the average home during the winter months.

Too many of these winter insect occupants of the home are labelled undesirable, for in some cases they raise havoc with the economic prosperity of the home or seriously affect the health of the human inhabitants. In other cases they are undesirable by merely making themselves a general nuisance. What a fine opportunity for correlating the study of insects affecting the home with the hygiene and health units of study. These little hexapods are too often the source of the health or economic troubles in the home. Why not study the source of the trouble and thus make biology a functional, meaningful, practical subject? What then are these insect creatures which demand attention and which justify time and consideration in the functional high school biology of today?

THREE INSECTS WHICH may be considered together are the clothes moth, the carpet beetle, and the tobacco beetle. According to a recent pamphlet dealing with fabric insects, it is estimated that these three are responsible for 99% of the damage to fabrics and

animal products used for clothing and for house furnishings. All kinds of woolen goods, felt, furs, feathers, leather and hair products are attacked by these insects.

Several species of clothes moths may be found infesting the home, but in any case the adult is a small buff-colored moth between one-fourth and one-half inch long. The margin of the wings is bordered with a fringe of hairs and it is in this way that the clothes moth is easily distinguished from other small moths of similar color. Also the clothes moth responds negatively to phototrophisms and hence is not attracted to lights as are most of the other small moths of similar appearance. The damage is done in the larval stage and not by the adult.

The carpet beetles, or buffalo beetles as they are sometimes called, are small oval beetles about one-eighth inch long with mottled red and white markings on the almost black wing covers. With these also, as in the case of the clothes moth, the damage is done in the larval stage.

THE TOBACCO BEETLE is a most serious pest among tobacco products and also does much damage to upholstered furiture. The small, somewhat oval, light-brown adult is only about one-sixteenth inch long.

The control measures for the three insects pests so far discussed are quite similar. Fumigation with hydrocyanic acid gas (very poisonous to the human) or with carbon bisulphide is effective. Paradichlorobenzene or naphthalene at the rate of one pound to ten cubic feet of space in confined areas is also effective. Fumes of aqua ammonia or of ammonium hydroxide in tight clothes closets or chests will kill all stages. A thorough saturation of infested overstuffed furniture with a good grade of gasoline is also effective.

Silverfish, which are silvery, grayish or brownish wingless insects, are slightly less than one-half inch long. They may be found in semi-darkened situations where they shun the light. They chew the bindings of stored books, the glazings of paper, and they may even be found eating the paste from wall papers and so cause it to become loose from the wall. Sodium fluoride either in paste or powdered form may be placed near runways to effectively control this pest.

THREE SPECIES of cockroaches normally may be found infesting the home. These are the little tan German cockroach, which attains a length of about one-half inch; the larger, blackish, wingless Oriental roach; and the brownish American species, which may be one and one-half inches long. Their filthy habits along with the fact that it is suspected that the roaches are carriers of certain human diseases and the fact that they render foods that they come in contact with unfit for further use makes the cockroaches particularly undesirable in the home. Sodium fluoride either in dust or paste form placed where the roaches frequent is considered effective.

Another group of insects which invade the home and make themselves serious nuisances are the ants. A number of species of ants may be found in the home, but certain species are the most common. One of these is commonly known as the little grease ant, being somewhat reddish-brown in color and quite small. It prefers foods which are greasy, such as lard, bacon or other meats. The odorous house ant, which is black, measures less than one-eighth of an inch in length, and has a pronounced rotten pineapple odor when crushed, is perhaps the most common of the household infesting ants. It prefers sweet foods as do most of the other species. There are several species of ants other than these that infest the home, but the control treatment for nearly all is essentially the same.

AMONG GENERAL control measures for ants are the trapping method, the poison bait method, and fumigation. In trapping, we merely place a sponge containing the food of the particular kind of ant, either grease or sweets, in a can and place the can near the runway of the ants. When goodly numbers of ants have collected

on the sponge, hot water is poured into the can. In this way the colony can be greatly reduced in numbers and finally dispersed. If specific directions for making poison baits for ants are desired, refer to the bibliography. If the ant nest in the ground can be located, pour in a tablespoonful of carbon bisulfide and close up the opening so the fumes will penetrate the nest and destroy the colony.

The larder beetle, the adult of which is about one-third inch long and of a dark brown color, has a rather wide yellowish band across the front part of the wing covers. This beetle feeds on meats and other animal products, particularly the stored meats, such as dried beef, bacon, ham, beeswax, etc. Carefully wrapping the meats in paper or cloth or storing the food products in cold storage will control this insect fairly well.

IT WOULD BE an endless task to go on and name, describe and suggest control measures for all of the insects which may infest the home. However, a number of the remaining insects affecting the home will be named in their respective food groups in the hope that the bibliographical citations will be consulted for this very valuable and practical phase of insect study.

Attacking cheese:

(1) Cheese skipper—Piophila Casei, Order Diptera.

(2) Cheese mite—Tyroglyphus, Order Acarina.

Attacking flour:

(1) Flour mite — Tyroglyphus, Order Acarina.

Attacking stored grains, seeds, or grain products:

(1) Granary weevil — Sitophilus Granaria, Order Coleoptera.

(2) Rice weevil—Sitophilus Oryzae, Order Coleoptera.

(3) Confused flour beetle — Tribolium Confusum, Order Coleoptera.

(4) Saw-toothed grain beetle—Oryzaephilus Surinamensis, Order Coleoptera.

(5) Meal worms—Tenebrio Molitor and Tenebrio Obscurus, Order Coleoptera.

(6) Cadelle—Tenebroides Mauritanicus, Order Coleoptera.

(7) Angoumois grain moth—Sitotroga Cereolella, Order Lepidoptera.

(8) Mediterranean flour moth—Ehpestia Kuehniella, Order Lepidoptera.

(9) Indian meal moth—Plodia Interpunctella, Order Lepidoptera.

Attacking stored peas and beans:

(1) Pea weevil—Mylabris Pisorum, Order Coleoptera.

(2) Bean weevil—Mylabris Rufimanus, Order Coleoptera.

Note: The above classification is taken from Metcalf and Flint—Destructive and Useful Insects.

IN CLOSING the discussion of the insects injurious to the home, mention must be made of the little red and black box elder bug. This insect, however, is more of a nuisance than it is a pest. It creeps in through the cracks and crevices of houses in the fall and spends the winter inside the warm home where it becomes a nuisance as it crawls on the walls and furniture and onto the occupants of the home. Ridding the home grounds of any box elder trees will go far in controlling these bugs.

It would be wrong to leave the impression that all insects and related animals which may be found in the home are injurious, for such is not the case. The house centipede or the so-called hundred legged worm is quite beneficial and, according to Metcalf and Flint, their food consists of small insects such as cockroaches, clothes moths and house flies. If, however, they become so numerous as to become a nuisance, a liberal sprinkling of pyrethrum powder along their runways will control them.

This discussion by no means exhausts the materials at hand for the effective study of this very functional biology, but rather it opens an avenue worthy of consideration in an already crowded course. It is hoped that several allied discussions emphasizing the modern practical biology will follow this discussion in future issues of this periodical.

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# THE SCIENCE TEACHER

**201 North School Street, Normal, Illinois**

**A Journal of**
**The Illinois Association of Chemistry Teachers**
**The Illinois Biology Teachers' Association**
**The Indiana High School Chemistry Teachers' Association**
**And Serving Other Science Associations**





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## ASSOCIATION MEETINGS

Both the Illinois Association of Chemistry Teachers and the Illinois Biology Teachers' Association are holding their regular meeting in conjunction with the High School Conference at Uurbana November 3. The meetings promise to be very worthwhile as may be seen from the program given on page 20 of this journal.

The chemistry teachers in their afternoon session have the opportunity to get "up-to-the-minute" knowledge of one of our very important and rapidly developing fields, that of the plastics, from an outstanding man in that field. Another feature that Mr. Ray Soliday, chairman of the session, has wisely included and that is of special interest to teachers is a discussion of the work of the National Committee on Science Teaching. The work of this committee offers considerable promise toward the improvement of science instruction and so is entitled to the complete support of the state chemistry association.

The biology teachers under the leadership of Mrs. Grace L. Cook have a decidedly outstanding program for the day. Dr. Maud Slye of the University of Chicago is a national figure in cancer research and will present an excellent paper along one of the frontiers of biology. Many of the other features are of a very practical nature and in some instances represent in part the work of state committees.

Both associations plan get-together luncheons which are always well attended. The fellowship of the noon hour should never be overlooked. Aside from the stimulus it gives to teachers, it often leads to personal advancement.

## OUR FRONTISPIECE

The Bad Lands of South Dakota as shown on the journal cover are a classic example of soil erosion. The picture was presented by Miss Mabel Spencer of Granite City, Illinois. We would appreciate receiving from our readers pictures of interest in the science field that are suitable for the cover of this journal or possibly for an inside picture section should suitable pictures warrant it.

# The Problem of Keeping Up-to-Date

EDITORIAL

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Many teachers of physical science in colleges and universities tend to criticise the high school training of the entering college freshmen on the grounds that the students are poorly informed in regard to such topics as "recent trends" and "new developments" in the special sciences. This criticism is often indirectly aimed at the high school science teachers.

To be sure the "live" high school teacher should keep abreast of the times and read literature of such nature that he is always able to supplement and correct the textbook used in the classroom. But when one stops and considers that most of our high school teachers are already overloaded with classroom work to the extent that they must devote time during the evenings and week ends for such things as the correcting of papers, making out examination questions, and caring for the laboratory, he encounters the question, "When can the teacher find time to keep informed and how may he obtain the necessary literature?"

During the summer of 1938 the writer had occasion to present a course in "Methods" to a group of active chemistry teachers who were attending summer school while working on advanced degrees. One may state that in a group of seventeen such students we may have had a selected superior group who were more than willing to better their present positions as science teachers. In an informal canvas of this small group, the following facts were brought out quite definitely.

(1) High school administrative officers feel that some journals are primarily for teachers and do not merit subscriptions by school libraries, while others covering more than one field of science are more worth-while to the school as a whole. Many school libraries subscribe to the latter type of journal.

(2) In some journals many articles are much too technical and too highly specialized to mean anything to the average high school teacher. Also, there may be very few articles dealing with education, educational trends, examinations, etc.

(3) High school teachers are very anxious to obtain interesting and informative articles which can be easily read and understood, and which bring to them new developments and trends in the fields of science of their choosing. For example, when the class was referred to two articles in Industrial and Engineering Chemistry, one member of the class reported that he had found considerable new material concerning the chemistry of sulfur and phosphorus which he expected to use in supplementing the textbook in subsequent classroom discussions.

(4) There is a definite need for an abstracting bureau or clearing house whose prime function would be to call attention of high school science teachers to worth-while items which appear in technical journals obtainable in large city or college libraries. Some state libraries also have these journals on file. Teachers may obtain certain volumes from these libraries upon request.

**The Science Teacher** is an organ which could serve as such a clearing house, informing its subscribers in regard to the location of such articles as would interest fellow-teachers in the fields of all sciences. Perhaps it would be well to devote a column or even a page of each issue to such articles. Each title and reference should be accompanied by an abstract of 40-100 words giving the essential summary of the reference. In no case is a single statement

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# How Much Mathematics in High School Chemistry

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THE QUESTION: "How much mathematics in High School Chemistry?" may be interpreted in at least two ways: First, how much mathematics should a pupil know before entering the high school course? This certainly is not the question of interest to us at this time. Second, how much mathematics should be required in the high school chemistry course? This is the question to which we seek an answer. The implications here are obvious. If too much or too little, we must modify the course. If the requirements now are adequate and satisfactory, we may continue undisturbed upon our way and give time devoted to this sort of a discussion to other matters. The question, however, does disturb us. The content of the course is involved. A complete, single answer acceptable to all probably will never be found and probably never should. The type of course taught determines the mathematics and there will be, or should be, as many types of courses as there are needs and teachers alert enough to meet those needs.

Different school communities with different educational needs require different types of courses. An agricultural community might conceivably have a course with different emphases from that of an industrial or manufacturing community. A community that sends over half its high school graduates to college will probably demand something different from a community that sends ten per cent or less.

AND INDIVIDUAL pupil differences within a school require different treatment and different emphases. Some pupils are so different, in fact, they might well be advised to take some other course if sectioning be impossible. We all pride ourselves upon the ability to teach chemistry to any pupil, but there are those whom we would rather not teach unless we are able to get all that kind together in one class.

These differences are being the subject of intense study. Out of that study are coming modifications variously characterized as "descriptive chemistry," "consumer chemistry," etc., not to mention the profound changes which may be expected in our entire physical science program within the next decade. We welcome these studies. Only in this manner will we be able to determine the content of an effective course for any school community.

Chemistry is a science. I would like every pupil of mine to realize that, in some measure, before he leaves the course. Lord Kelvin said:

> "When you can measure what you are speaking about and express it in numbers, you know something about it, and when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind It may be the beginning of knowledge, but you have scarcely in your thought advanced to the stage of a science."

THE HIGH SCHOOL chemistry course may be only a beginning, but it would be unfortunate if we fail in a course so well adapted to that purpose to have the pupil see that he is working in a science whose laws have grown out of measurements and numbers and whose techniques offer a unique method of solving problems — not merely those of chemistry, but other and urgent ones confronting the civilized world today. Until a pupil grasps something of the quantitative aspects of chemistry he does not recognize it as a science. To him chemistry is a sort of magic, an illusion not entirely dispelled since the days of the early alchemists.

With the introduction of symbols and formulae, atoms and molecules take on quantitative significance. A symbol does not merely represent an elementary substance but an atom of the element with a definite weight. A formula does not merely represent a compound but a sub-

stance made up of a definite number of atoms whose combined weights give the weight of the molecule. The argument is streng hened when chemical changes are studied and equations written for them. Two grams sodium bicarbonate will produce one gram carbon dioxide and the pupil can verify — or discover, depending upon your approach — that fact for himself.

THE TEMPTATION here to say a word about the technique of problem solution is irresistible. Suppose the problem be:

How many grams of carbon dioxide are liberated from ten grams of sodium bicarbonate in a baking powder?

Our usual procedure, of course, is:

1st the writing of the equation.

2nd calculation, from the atomic weights, of the total weights of bicarbonate and carbon dioxide which appear in the equation.

3rd the mathematical solution.

Setting up the proportion

$$84/10 = 44/x$$

is the easy way. But underlying this is the reasoning taught in the lower grades, viz.,

If 84 grams $NaHCO_3$ yield 44 grams $CO_2$

1 gram $NaHCO_3$ yield 44/84 grams $CO_2$

Then 10 grams $NaHCO_3$ will yield 10 x 44/84 grams $CO_2$.

The calculation of the yield from unit quantity, 1 gram sodium bicarbonate, is the fundamental first step. This yield from unit quantity is thereafter multiplied by 10 to find the yield from 10 grams. (Or divided into some given weight of carbon dioxide had the problem been to find the amount of sodium bicarbonate to produce the weight of carbon dioxide.

Too large a percentage of our pupils become confused with the direct and inverse proportions of Charles' and Boyle's Laws. This confusions is traceable to a misunderstanding of the underlying mathematical steps. We can anticipate and go a long way toward dispelling this confusion before coming to the gas laws by reviewing the steps referred to. After that the solution by ratio and proportion is suggested as a short cut. In my opinion it is a blunder to permit the use of ratio and proportion until assurance is given that the time-honored method of the early grades is understood.

UNFAMILIARITY with grams, liters, cubic centimeters, and milliliters is likewise a source of confusion and mistakes. If in doubt about this, substitute a problem with identical mathematical operations concerning cents and sodas or dollars and dance bids. Disillusionment follows immediately. Lightning calculators will be discovered among those unable to solve the simplest chemical problem. This unfamiliarity is overcome by use of these terms in interesting problems as the subject of chemistry develops.

With the gas laws comes the question: Shall I teach the laws or teach something about them? In some classes, and with some pupils, it may be pointless to insist upon proficiency in the solution of the variations involving aqueous tension and differences in water levels. But we recall:

> " . . . when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind."

With Charles' Law it is essential to an understanding of the law, and of the kinetic molecular theory of gases, to see that the volume varies **directly** as the absolute temperature — a **direct** proportion. With Boyle's Law it is essential for the same reasons to see that the volume varies **inversely** as the pressure — an **inverse** proportion.

THERE IS NO BETTER way to state these facts, preferably discovered first through experiment, than by numbers (cubic centimeters, degrees, millimeters of mercury). Though "mathematics is a language," as Willard Gibbs declared in what has been said was his longest public utterance, we need not make the mistake of insisting upon such precise statements of all the laws and principles encountered in an elementary science. But just as the chemical equation is a precise summary of an actual

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# Recent Developments in the Nitrogen Industry

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**Research in nitrogen chemistry has opened up many new industrial possibilities. Articles on recent developments in other fields of science are being prepared for this journal to help the busy teacher keep informed.—Editor.**

THE STATEMENT is often made by teachers of chemistry that it is impossible to acquaint students with modern technical developments because of the fact that text books of General Chemistry are so obviously far behind the times in the presentation of such material. However, the fault lies not with authors of General Chemistries. All competent authors in writing or revising their texts make extensive use not only of trade and scientific journals, and of the patent literature, but in many cases they have access through industrial contacts with chemical developments even before these are publicized.

The answer is found in the fact that the development of a chemical process, or of a new chemical product, often requires years. It has been estimated that it takes, on the average, seven years from the time of conception of an original idea until a particular process or proluct is actually beginning to bring a return on the investment of time and money. The fact that a process works in the laboratory does not predicate its success on a commercial scale. The change from laboratory to semi-plant production requires that problems of design of equipment, materials of construction, temperature control and heat exchange be worked out in detail with the cost factor constantly in mind. If these problems appear to be surmountable then large scale production and sales development may begin.

EVEN SO, a great many questions must be answered. What competitive products are already on the market? In what ways is the new product superior, or in what way does the new process effect a saving of time and money over older processes? Is the demand for the product sufficiently great to warrant the extension of productive facilities? These and countless other questions must be answered to determine if the new product, or the suggested improvement, warrants the consideration of the chemical manufacturer. Even after a new process is placed on a productive basis, or after the new product has been placed on the market, it is perfectly obvious that details will not be made public for some time thereafter.

The teaching of the facts of descriptive chemistry must always suffer under these circumstances. But these difficulties can, in part, be overcome by associating chemical facts with the economic picture and by stressing those details which warrant emphasis because of their economic value. But how can this be done? A recent article by Keller and Quirke* suggests one method of approach. A consideration of the important geologic raw materials of the chemical industry indicates where process improvents and new products may be expected. Why? Because the essential starting materials as furnished by nature are cheap and readily available.

THESE WRITERS LISTED the 150 most important products of chemical manufacture "on the basis of production values and general usefulness" and then proceeded to trace them back to their geologic raw materials. A portion of their table is reproduced here. The numbers indicate "the number of times each particular raw material was employed in the actual manufacture, not in the purification or treatment," of these 150 chemicals.

| | | |
|---|---|---|
| 1. | Water | 99 |
| 2. | Air | 96 |
| 3. | Coal | 91 |
| 4. | Sulfur | 88 |
| 5. | Mineral Salt | 75 |
| 6. | Limestone | 63 |
| 7. | Sulfide ores | 32 |
| 8. | Brines | 24 |
| 9. | Petroleum | 23 |
| 10. | Natural gas | 16 |

* Economic Geology 34, 287-96 (1939)

Among the first ten of these geologic raw materials seven are the basis of the inorganic chemical industry. The two which are most widely used — water and air — are of interest, respectively, as the commercial sources of hydrogen and nitrogen. Is it any surprise, therefore, that ammonia, obtainable by direct combination of these two elements, has assumed a predominating position as one of the most valuable and essential products of chemical manufacture?

THE HABER PROCESS, in commercial production since 1913, heralded the beginning of the modern chemical age. Through its extension ammonia has become the cheapest anhydrous solvent available. What should be more logical than to use it industrially as a solvent? Recovery is simple and modern high pressure equipment permits the extensive use of liquified gases. Some sodium carbonate is now produced in competition with the older Solvay process from liquid ammonia, carbon dioxide and salt with ammonium chloride as a by-product. Unique solubility relationships in liquid ammonia permit separation of sodium chloride from potassium chloride, purification of potassium cyanide, and of rock salt — to say nothing of its extensive use as a solvent for countless organic compounds.

The development of the Haber process brought about some other interesting contemporaneous developments. To lower the price of ammonia, it became necessary to produce hydrogen more cheaply. Technically, hydrogen is manufactured chiefly by interaction of steam and coal followed by further reaction between water gas and additional steam over a catalyst at about 400° C. Large quantities of carbon dioxide are thus obtained as a by-product. Recation of ammonia and carbon dioxide to give urea was a logical development, especially since the urea-formaldehyde resins demanded a cheap source of urea. But it became necessary to produce ammonia at a still lower cost and this was possible only by developing synthetic processes using hydorgen, but producing products of greater value. Consequently, syntheti ammonia plants with their high pressure equipment launched into the production of formaldehyde, methanol and other alcohols from water gas, even as they are now turning their attention to the production of synthetic petroleum.

ONE OF THE MOST important inorganic chemicals is nitric acid. It is used in the manufacture of countless products so vital and essential in modern civilization both in times of peace and war. Practically all the nitric acid is now made by the oxidation of ammonia. Synthetic sodium nitrate now competes easily with the imported natural product and furnishes a large share of the domestic demand. The old electric arc process? It has passed into history and has been used nowhere in the world since 1927!

Cheap synthetic nitric acid also paved the way for the production of chlorine and sodium nitrate from salt and nitric acid. The new process has an interesting economic feature in that chlorine production becomes independent of the demand for caustic soda. The latter is still produced to the extent of 50% by the old lime process, the remainder having been produced chiefly by the electrolysis of brine. The alkali and chlorine industries were intimately connected with the result that price fluctuations and demand for one product influenced the other.

Various oxides have been used for years as abrasives and refractories because of their high melting points and their hardness; now the nitrides of such elements as boron, tantalum and silicon are used for similar purposes. These nitrides have extremely high melting points and are very hard. Like the oxides they are quite inert to many chemical agents.

ATTENTION HAS also been turned to certain nitrogen-containing acids such as sulfamic acid, $NH_2SO_3H$. This new inorganic chemical is a stable, nonhygroscopic solid, readily soluble in water to give a strongly acidic solution. It is predicted that sulfamic acid will in time displace such acids as acetic, oxalic, lactic and tartaric acid. Ammonium sul-

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## Science For Society

EDITED BY JOSEPH SINGERMAN

**A department in which science is presented in its close relationship to the individual and in which guidance is given in causing the individual to recognize the methods of science and its vast social implications.**

" . . . Neither in human nature nor in social relations has progress kept pace with science. This is not the fault of science, but rather of man and of society . . . The fact is that social progress has moved so much slower than science that one might say that scientific progress is matched against social stagnation. Many thoughtful persons are asking, 'Will science, which has so largely made our modern civilization, end in destroying it?'

"The greatest problems that confront the human race are how to promote social cooperation; how to increase loyalty to truth; how to promote justice, brotherhood; how to expand ethics until it shall embrace all mankind. This is a problem for science as well as for government, education, and religion . . ."

THESE EXPRESSIONS of thought commanded a high degree of respect, and a large measure of attention, for the message was presented by Dr. Edwin Grant Conklin, not quite two years ago, before the annual meeting of the American Association for the Advancement of Science. (N. Y. Times, 12/28/37). It was upon the occasion of his retirement from the presidency.

How mankind has benefited from science has long been a popular topic of discussion. But, unfortunately, less attention has been given to the vast possibilities of science toward benefiting the human race. Moreover, misapplications and unwise introduction of scientific discoveries and inventions have in countless ways burdened mankind with miseries. So serious has this situation become that leaders in modern scientific thought have become concerned lest science destroy our civilization.

Education, in our democracy, must assume an appreciable measure of responsibility for imparting to our citizenry an understanding of the meaning of science; its method of procedure; how it is being misused; how it can be utilized to the best advantage toward the betterment of human life. American science teachers acknowledge their share of this responsibility. We want to teach science, not merely as a body of organized knowledge, but as a body of knowledge and a method of thought in relation to its potentialities for the benefit of society. Our future citizens must be sent forth prepared to assure society of the proper use of this powerful tool.

**Science in Relation to Society** will appear as a regular feature section in this journal. With the above-mentioned basic objective in mind, I shall endeavor, under this title, to show how our science subject matter may be presented in order to serve worthy social needs. I am quite aware of the fact, however, that the individual teacher's personality enters into good teaching and that every classroom situation is unique. For these reasons what constitutes an excellent procedure for one teacher in a particular classroom situation may not without modification be transferred to every other classroom situation. Therefore, it will be intended that my remarks be suggestive, rather than a final, fixed formula for classroom procedure. This section is intended to serve your interests and needs, and you are invited to make comments or suggestions. They will be gratefully received.

The following suggests the general path, along which pupils may be led, in teaching the attitudes of open-mindedness and tolerance.

### TEACHING OPEN-MINDEDNESS AND TOLERANCE

IF YOU WERE TO GO to the top of your house and drop two stones, a rock and a large stone, which would reach the ground faster? This simple question was answered by Aristotle over two thousand years ago. Of course many people gave the same answer, but I mention Aristotle because he was one of the most learned and respected men of ancient time. People did not question any statement made by him. In fact, as the centuries went by, long after his time, faith in Aristotle's teachings became so strong that it was considered a crime for anyone even to suggest that Aristotle may have been mistaken in

anything he said. Doubters sometimes were even put to death.

In this instance, it was a very simple question that Aristotle answered. A large stone, he argued, is heavier because it is pulled more strongly to the ground. Therefore, it will fall faster. Does it not, when dropped from an equal height, strike the ground harder? This, Aristotle argued, proves that a large stone falls faster than a small one.

Some two thousand years after Aristotle's time, Galileo, an old, grayhaired Italian professor, dared to announce publicly that Aristotle was wrong. The pebble and the rock, said Galileo, would fall with equal speed. Some people laughed at Galileo. Others were shocked to hear him thus denounce the sacred teaching of Aristotle. Some were furious with anger and demanded his imprisonment and, yes, even his life.

"ALLOW ME TO PROVE that I am right," said Galileo. In the presence of many people he climbed to the top of the leaning tower of Pisa. Over the edge of the tower he dropped a pebble and a rock, taking great care to let go of both at exactly the same instant. Both reached the ground together. He repeated this experiment. Again and again the light pebble and the heavy rock traveled with equal speed and both reached the ground at the same instant.

Onlookers could hardly believe what they saw, for such was their faith in the words of Aristotle. Some, in fact, did not believe, and walked off still insisting that Galileo was wrong. For those who were not open-minded, experimentation was useless. But the method of experimentation and the use of careful observation carried a force which open-minded people could not oppose. As the years went by the ancient superstition about the speed of falling bodies gradually disappeared.

There is a satisfaction in knowing whether a rock or a pebble, if dropped together, will fall with equal speed. But Galileo's greatness was not merely in the fact that he gave us the correct answer to this question. We honor Galileo because he demonstrated the value of experimentation. Moreover, he showed that it is important to be **open-minded,** because some of the beliefs we may now hold may some day be proven false.

THE NATURAL philosophers, as the early scientists were called, were learning the value of open-mindedness. No matter how sure one is of the answer to some question, no matter how "obvious" it seems to be, one must be always ready to consider new evidence and always willing to change one's opinion, provided the new evidence is acceptable.

Suppose tomorrow we find that a scientist has perfected a very delicate timing instrument. Suppose, further, that we use this instrument to check the speed with which stones of different sizes fall from a given height. Should we find after many careful trials that there actually is a slight difference in speed, we must, as open-minded people, be prepared to change our opinions with regard to this fact. Thus will understanding and knowledge progress and civilization improve. This is the way of science.

Those people, lacking open-mindedness, who refused to be convinced by Galileo's experiments, simply retarded their own mental development. They were satisfied to hold certain beliefs simply because they were stated by certain famous men of the past, or because no one for hundreds of years had questioned these ideas. Some of those people actually retarded the progress of science by being intolerant of others holding opinions different from their own. **Intolerance** is the attitude of refusing to permit others to think or act except in accordance with one's own belief.

SUCH PEOPLE did many things to cause the early scientists to suffer. They called Galileo a heretic and a wrangler, and threw him into jail. These people held back the progress of science by refusing to permit the early scientists to carry on their work and to express their opinions.

But as the years went by there were more and more people who were both

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EDITED BY DR. KARL ORLEIN
State College California, Pennsylvania

A department for giving recognition to outstanding work by science club students in State Junior Academies of Science. Information concerning work of special merit is desired by Professor Karl Orlein.

# A Study of Air Resistance

A SCIENCE CLUB PROJECT

HOWARD S. McCORD, JR.
Upper Daily High School Upper Daily, Pennsylvania

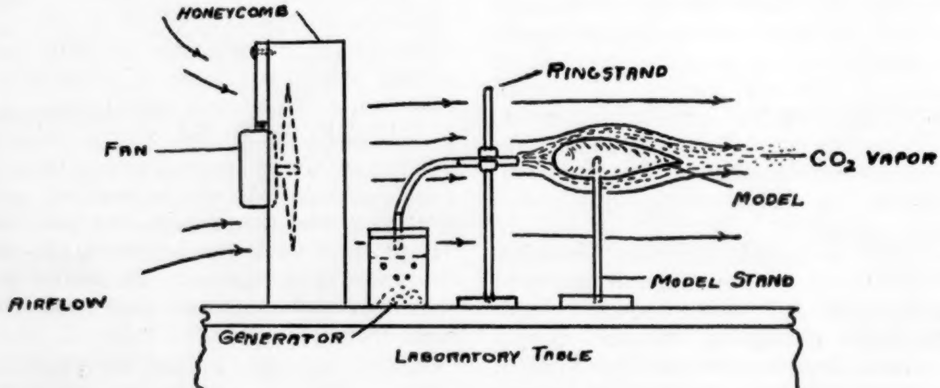
**Purpose:** To study the flow of air around objects of different shape.

**Apparatus:**

I. Honeycomb and Fan Unit. An ordinary household electric fan with a blade diameter of ten or twelve inches is desirable. A fan with larger blades can be used if speed of the motor is variable. Otherwise, the air will be moved too rapidly, thereby destroying the true flow of vapor about the object tested.

Air leaving the rotating fan blades possesses a circular path of motion. Since this is undesirable, a honeycomb must be inserted between the fan and the testing "chamber" to straighten the airflow. The honeycomb, though its construction may be tedious, is very simple. A number of strips of pasteboard tubing (mailing tubes) about one inch in diameter, are cut into segments two inches long. Pile these pieces up to form a rectangular solid. A drop or two of wood glue placed on each piece before assembly will hold them firmly together. A wooden frame built to fit around them adds to the general appearance and strength. The dimensions of the honeycomb will depend on the method used in mounting the fan, its weight, and blade diameter.

II. Vapor Generator. Dry ice ($CO_2$ in the solid state) is probably the most suitable producer of a dense white vapor. The "ice" is obtained at a cost of about seven cents a pound from ice cream plants, or directly from the carbon dioxide manufacturer. If a large wide mouth bottle and one-hole rubber stopper are not available, a generator can be made from a saltine or cracker can. Only one addition is required, namely, a fitting in the lid for a piece of rubber hose. A two-inch length of copper tubing of about 3/8 inch inside diameter is easily soldered into the metal lid so that 1 inch is inside and 1 inch is outside




Arrangement of Apparatus for Study of Air Flow

★

Honeycomb Unit Straightens Air Flow

★

the con. Dry ice vapor is produced by placing the solid "ice" in the bottom of the generator, and adding water (preferably hot).

III. Ring Stand with Clamp Attachment. A piece of ½ inch inside diameter glass tubing about 5 inches in length may be used to direct the flow of vapor over the front of the model. Connection between the glass tubing and the generator is made with a length of rubber hose. Care must be taken to eliminate all unnecessary hose.

IV. Model Supporting Stand. The stand used to support the models consists of a flat wooden base and a vertical rod. Each of the models, if constructed of wood, should have a ⅛ inch hole bored several inches into its lower surface, into which the rod can be inserted. Thus, a change of models may be executed quickly and with considerable ease.

V. Models:

A. Flat Plate. A flat plate having a square face (4 x 4 inches) is cut out of ¾ inch lumber.

B. Sphere. A sphere is readily constructed by cementing a small piece of wood, containing a hole, on the surface of a four-inch diameter smooth rubber ball.

C. Streamlined Solid. Best when turned out on a lathe. Six pieces of white pine ¾ x 4½ x 12½ inches are glued together to form a solid piece 4½ x 4½ x 12½ inches which is a suitable size for turning.

D. Airfoil. An airfoil model must be made by hand. Two pieces of white pine ¾ x 6 x 8 inches are glued together and shaped with a wood rasp, plane, and sandpaper. Most models of this type are patterned after the Clark "Y" airfoil, which is illustrated and explained in almost every aeronautics textbook.

# Experiment With an Electrocardioencephalograph

SAMUEL CRAWFORD

Oreal High School — Lawrence, Kansas

WHEN THE average man hears the word, Electrocardioencephalograph he is liable to blink his eyes in amazement that there could be such a word in the English language. In reality, it is a combination of four words of Greek derivation. These are: elektron, meaning amber; kardia, meaning heart; emkephalos, meaning brain; and graphein, which is the verb, to write. Thus the electrocardioencephalograph becomes an electric heart and brain writer.

The electrocardioencephalograph consists of two instruments which are used in clinical work quite often. These are the electrocardiograph and the electro-

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# The Scientific Method

W. H. RODEBUSH

University of Illinois

Urbana, Illinois

(Concluded from February Issue)

THE OLDER EDITIONS of scientific books were not untrue, they were incomplete. And so are our books incomplete. The acquirement of scientific truth is a slow accumulation It is not like the achievement of a sculptor or a poet, a finished production. It is rather like that process of building a cathedral as it was done in the Middle Ages by one generation after another. The great cathedrals were never finished, at least the greatest ones are not. There is something incomplete and imperfect about them. And so with any human accomplishment which involves the cooperation and coordination of effort of many men not only of one generation but of succeeding generations, it must always appear incomplete and imperfect and ever be subject to the criticism that it is not one of the eternal varieties.

Now since the scientific method has accomplished so much for us in the world of medicine and hygiene, for example, one must ask if it should be applied to all of our everyday affairs of life. It has only been used by a few specialists who touch our lives at a few points. Should it not be used by everyone in his daily life and business? The answer is it should and they should. And where is it to be acquired except in school and there from the teacher of science. The logic here is faultless and the teacher of science in the school and in the high school especially will find himself loaded with the responsibility of preparing his pupils not in a particular science but for living and life. The old precepts of the classics and religion have lost their validity and the wisdom that the ages have accumulated does not help us much in the present day world. We must be prepared to face new situations and interpret them in terms of careful observations and intelligent conclusions.

CERTAINLY WE do need to use the scientific method in everyday life. I read that two billion dollars a month is spent on gambling in this country on games ranging from pinball to the dog races. This, of course, does not include the stock market. Now, no one who has practiced the scientific method would ever gamble at least with the idea of increasing his financial resources. A little application of the scientific method will show you that you can't win. I am reminded of the incident related in a recent best seller written by Robert Briffault in which a group of people are gambling on the Riviera. Included in the group are a young Cambridge biologist and a business man whom, to avoid offense we will designate as a Scotchman. These two would spend a few francs gambling each night as a social gesture and quit. The rest of the party could never comprehend this because they thought if they were winning they should continue their winning streak and if losing, they would try to recoup their losses. The young biologist knew that there is no such thing as winning streaks or losing streaks but that the longer he played in general, the shorter he would be in his finances. And the so-called Scotchman made a negative application of the scientific method by asking him how he could be expected to bet when he did not know what number was going to come up.

It is a serious task that we teachers of science have charged ourselves with: that of teaching the youth to turn to the scientific method in a world where the old sanctions and old precepts have lost their meaning. Shall we accept this charge as a serious burden and go it whole hog, to use the vernacular?

Well, not too seriously. While the scientific method probably has no limitation, the human brain has. Many of the practical situations in life are so complex that we can not even observe

all the cogent data, let alone draw conclusions. Let us return to the illustration of weather forecasting. The weather forecaster looks over the map and sees a situation that resembles closely sometime last year when it rained. He predicts rain and misses it 100 per cent. Why? Well, because his observing stations were too far apart and his observations too meager. The same situations had not occurred twice. What the weather forecaster is doing is reading a map and guessing, and if he is right 50 per cent of the time, he considers himself lucky.

This is the situation that we meet in politics and economics. The same situation never occurs twice. The details of the picture are too complicated for observation and as many different conclusions are drawn as there are observers and none of them are right more than occasionally. What can we do in a situation too complex for detailed observation? Well, of course, there is always the possibility of changing the scale of observation so that unimportant details are ignored and only significant facts recorded. An illustration of this is the Brownian Motion. If we could observe single molecules, we should see nothing but an utterly chaotic motion. If we observe the smallest particles visible with a high power microscope, we see that they are agitated but we should have to observe them for an impossibly long time to see that they were really moving from place to place. But if we use the ultra microscope and observe particles too small for direct visibility but ten thousand times as large as molecules, then we observe an erratic motion from place to place. We can work out a mathematical expression for the probability of this motion. The mathematical theory will not tell us where any particular particle will go but if we start with a large number of particles it will tell us how many of them will be any particular place at a certain time. It is like the problem of the random walk of the intoxicated man. The intoxicated man is returning home late at night. At every street corner he has four possible directions in which to go including the direction from which he came, provided he does not climb a lamp post. Where will he go at the end of an hour? Well, he will probably be at the police station. In this case we will make a common error in applying the scientific method if we assume that his walk is strictly random and neglect the action of outside agencies with directed forces.

Or to return to the prediction of the weather, meteorologists have recently discovered that observing the physical properties and motions of air masses at various levels, they can get a true picture of the weather on its way to happen and can actually make predictions which involve little more than the laws of inertia, just as the crest of a flood may be predicted for the lower part of a river. There is always the possibility that a complex organism such as our social, political or economic structure can be reduced in scale so that we shall see only the actual functional parts and their significant movements.

But we must close with a warning. A little learning is a dangerous thing and the attempt to apply the scientific method without adequate technique is sure to make the one who attempts it ridiculous. Everyone is familiar with scientists who are thoroughly competent and restrained in their own fields, who in their opinion in other fields exhibit the most unrestrained emotional thinking. These men simply lack the technique of the scientific method in these fields and, lacking it, they do what all human beings do when they do not know and do not know how to find out. A good example of this sort of thing is the stock market speculator who tries to be smart and outguess business conditions and government actions, and from his inadequate data only succeeds in losing his own money and doing untold harm to economic stability.

Finally, the scientific method can not be used as a religion. Its statistical results are not infallible for individual guidance. It may predict what you should do nine times out of ten but if it

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# Microscopy in High School Biology

PRESSLEY L. CRUMMY

Juniata College Huntington, Pennsylvania

THE HISTORY OF Biology is very closely tied up with the development of the microscope. From the earliest times until Hooke, Leeuwenhoek, Malpighi, Schultze, and the countless other early students of minute structure began an intensive use of the microscope, Biology was little more than Natural History. Since that time biological knowledge has increased by leaps and bounds. Without the microscope the extremely important cell law as it is known today could never have been established. Microscopy, then, must be an exceptionally significant part of any course that aims to introduce its students to the world of living things. Even as the first microscopists were amazed at what they saw under their crude lenses, so also is the student of today amazed when he sees this miniature world for the first or even the hundredth time.

This intensely interesting and even thrilling phase of biological study is too often neglected in the secondary schools. It would be interesting ot know just what proportion of our high schools have more than six microscopes with which to accommodate from five to ten times that many students. It is quite obvious that not more than one individual can satisfactorily use a single microscope at any particular instant. The instructor, then, must do one or another of two things if he is to show his pupils the world of microscopic life. He has either to use micro-projection or to have his students take "turn-about" in viewing these objects. Neither procedure is entirely satisfactory even though each has its use. A much more desirable plan is to have each member of the class or section equipped with a microscope so that all might work on the same phase of their biological investigation at the same time. However, the cost of standard microscopes is usually prohibitive.

THE SOLUTION TO this dilemma may lie in the use of less expensive instruments. There are on the market today a number of different makes of fairly good quality but low-priced microscopes that are quite suitable for high school work. These instruments may be purchased at prices ranging from one-fifth to one-third that of the standard ones, and will serve the routine needs of the high school student every bit as well. It is true, of course, that every biology laboratory should have at least one of the standard microscopes available for demonstration and micro-projection purposes. Care must be used in the purchase of lower-priced instruments in order that cheap quality be avoided. If one is not an expert in that field he should select a reliable company with which to deal and depend upon their choice. It may be possible to exchange some of the more expensive used instruments on hand for several of the lower-priced ones.

Many of the instructors of high school biology will feel that the cheaper microscopes are mere toys and probably most of the salesmen for scientific supply houses will discourage the use of these instruments for that reason. However, even if that were wholly true, an instructive toy that can be handled and used by the student is certainly oi more educational value than an expensive piece of apparatus which the pupil, to say nothing of the teacher, is afraid of breaking. After the student has become proficient in the use of the less expensive instrument and has learned to care for it properly, he can be rewarded with permission to use the better one. It seems evident to the writer that thirty or more of the cheaper microscopes would be more useful and make for a more interesting study of minute life than would eight or nine of the standard instruments, even though they would cost no more. In fact, it seems to him

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## NATIONAL COMMITTEE ON SCIENCE TEACHING

### An Open Letter

IT IS DESIRED TO call attention of all readers of this journal to what appears to be a remarkable opportunity to co-operate in an educational study of national scope.

I refer to the work of the National Committee on Science Teaching, recently organized by the National Education Association, with representatives from a number of the most prominent national scientific and educational societies. This committee began its activities in February, 1939, and its program is now well-organized.

The general committee, composed of fifteen members, has organized into these sub-committees:

**Philosophy or Frame of Reference**

This committee is to survey present reports and then formulate a complete and workable statement of a philosophy for the guidance of the National Committee.

**Social and Personal Needs in Relation to the Science Program**

It is the duty and opportunity of this committee to enlist all available agencies in working out the more specific needs toward which science teaching could contribute, together with hopeful procedures for meeting these needs.

**Evaluation of Materials, Methods, and Results**

To study the methods of effectively measuring these items. This committee is digesting data already available, using special studies, and analyzing methods and characteristics of superior teachers.

**Teacher Eduucation**

This group is studying the several problems concerning teacher training in the light of general education, special interests, and professional interests.

**Administrative Problems**

It is the function of this committee to get information about administrative policies and practices in administering the science programs in our schools.

AN IMPRESSIVE number of science teachers from all parts of the country have agreed to co-operate with this committee as consultants, acting as liaison between the committee itself and other teachers in the many state and smaller organizations. It is recognized that the program of the committee will succeed or fail depending upon the amount of co-operative effort of a very large number of teachers widely distributed.

**Illinois Teachers May Co-operate.**

There will be a meeting of the National Committee and consultants in Chicago on October 6th and 7th. There will be another meeting in February, 1940, in St. Louis. It is anticipated, however, that teachers co-operating with the sub-committees will carry on their work by correspondence, avoiding the burden of expense involved in attending meetings.

One member of the National Committee, Mr. Harold Metcalf, is an instructor in chemistry in the Oak Park, Illinois, high school. Of the consultants listed on bulletins of the National Committee, several are active members of groups supporting this journal. In the Indiana-Illinois area these include, perhaps among others:

C. D. Dilts, Central High School, Ft. Wayne, Ind. (Social and Personal Needs)

Dr. W. M. Gersbacher, S.I.S.N.U., Carbondale, Ill. (Social and Personal Needs)

R. H. Gocker, Oak Park High School, Oak Park, Ill. (Evaluation)

C. C. Hall, Senior High School, Springfield, Ill. (Philosophy — Frame of Reference)

P. K. Houdek, High School, Robinson, Ill. (Philosophy — Frame of Reference)

Dr. J. C. Hessler, Millikin University, Decatur, Ill. (Teacher Education)

T. A. Nelson, Senior High School, Decatur, Ill. (Evaluation)

R. E. Park, Oak Park High School, Oak Park, Ill. (Social and Personal Needs)

Ray C. Soliday, Oak Park High School,

(Continued on page 26)

# Conference Report on Health Education

(HELD IN NEW YORK CITY)

J. W. GALBREATH

East S. Louis High School East St. Louis, Illinois

A significant new force has been originated in the field of Health Education. Its scope is wide and its opportunity is great. Here is a first report on its organization.—Ed.

ORGANIZATIONS represented by delegates included the United States Public Health Service, the United States Office of Education, the National Education Association, the National Health Council and some twenty additional well-known health and education agencies.

The personnel of this committee included Professor Ira V. Hiscock of Yale University as Chairman and Dr. N. P. Neilson of the National Education Association as Secretary.

The general purpose of the conference was to guide initiative steps in formulating a program that would encourage school health education and particularly instruction with regard to syphilis and gonorrhea.

After preliminary meetings and reports, the final conference, at which approximately seventy delegates were present, concentrated on the following headings:

A. Interest in health education
B. Functions assumed
C. How organized to perform the functions
D. Problems relating to health education

The summary of these reports, by the appointed committee, indicated immediate practical plans might stimulate the financial support of interested organizations and secure the assistance of learned specialists. A special need was manifested to co-ordinate work attempted toward a common goal; whereby the public in general could be reached, thus making the program more effective.

Two items which stand out in the report stressed the fact that each group had created a body of specialized information within its own area of interest and that each had its own very definite channels through which it reaches its clientele.

There remains the need for co-ordinating all health and educational agencies that all their resources are made available and are understood. There is also specific needs for training health coordinators, personnel, to do their specific work in the school: such as teachers in health work and administrators.

Some vital questions raised but unanswered were: What are the nominal essentials for a health program? How do we transmit knowledge into action? How do we get health personnel to work together rather than independently? How do we get community interest and support for such a program? How can the mechanism by which co-operation can be secured be made more than mere words?

In an attempt to answer these questions suggestions were made that creditable programs now in effect be reviewed to determine the success of varying methods of health education. That is, courses in health instruction, integrated courses, courses which include health instruction in Biological Sciences or Home Economics were recommended as models for trial periods.

In the proposed plan of action the committee presented, after proper discussion and modification, the following recommendations, in summary:

1. Health education should be a program that involves the entire community. It should interrelate school health and public health. Many National agencies already organized in the field should make their resources more readily available through co-ordination of efforts.

2. It is proposed that a national committee on co-operation be organized from the representatives of the agencies invited to this conference and such other

organizations as have a definite relation to the field of school health education, for the purpose of improving a definite school health educational program.

3. The objectives of the proposed project should include; development of an adequate school health education, stimulate public interest in and support of school health programs, make present health educational materials and services more accessible and stimulate production of additional materials.

Secure the services and reports of specialists in the field and make more effective co-ordination among agencies in the use of resources.

4. Further suggestions include the periodical preparation of a directory of health educational materials, co-operation in the production of additional suitable materials for school use and the distribution of this material in the schools.

It would appear that a very worthwhile attempt has been made and additional support should be given to the present efforts to establish in the public schools of this country a well-rounded general health educational program that is much needed.

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## SCIENCE FOR SOCIETY

(Continued from page 11)

open-minded and tolerant. They were, and are, the people who surely and steadily have been building the road of science, the highway to truth, inch by inch, yard by yard, mile by mile. Here and there, through the generations of time, there appeared among them a genius, a giant who helped them over a difficult mountain, or through a bewildering jungle. Among these great men was Galileo.

IT IS QUITE a simple matter to convince the student of the value of open-mindedness and tolerance in the work of science. But, as experience has shown, that is not enough. Though we are teachers of science, let us remember that we are primarily teachers of American youth, those who soon will be entrusted with the care and extension of our democratic institutions.

It is very important at this point to show how open-mindedness and tolerance, or their lack, function in social situations. Ask the pupils to cite personal experiences, or the statements and actions of prominent people, to illustrate the part played in everyday life by these attitudes. Problems centering around racial, religious and political questions are rife with suitable examples. Even the social life of the adolescent, where it tends to conflict with standards of conduct and behavior set up by their elders, calls for the operation of open-mindedness and tolerance. They may be reminded that these attitudes must function both ways.

Accounts similar to that of Galileo may be given of the work of Vesalius, Harvey, Redi, Priestley and Lavoisier. (These may very well form the basis for student reports.) Vesalius, for example, was persecuted because of intolerance. People were so enraged over exaggerated and distorted stories about his dissections of human bodies that they threatened his life and caused him to flee his native land. Harvey met the storm of anger, aroused by the announcement of his discovery, with the notes he had carefully made of his painstaking work over a period of twelve years. As to Redi's work with the fly maggot, it seemed obvious to everybody at that time that maggots developed from stale meat, for anyone could see the maggots develop and note that they do not crawl into the meat. However, open-minded people were convinced by Redi's carefully controlled experiment that fly maggots did not develop from stale meat.

Much greater intolerance, however, was shown to Priestley. The frenzy of a Birmingham mob left no room for open-mindedness and tolerance when, because of his sympathy for the French Revolution, Priestley's home was set upon and burned. His expressed opinions made him so unpopular that Priestley felt compelled to leave his native land for America. The Parisian mob that beheaded Lavoisier was no more inclined to be open-minded and tolerant.

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Topic for the next issue: Science and Democracy.

# PROGRAM

## ILLINOIS STATE HIGH SCHOOL CONFERENCE

***University of Illinois, November 3, 1939***

9 a. m. Physical Science Section. Physics Building
Chairman: Nellie F. Bates, Champaign High School

The Evolution of the Science of Seeing and some Resulting Applications in the Educational Field—Dr. L. V. James, Lighting and Seeing Specialist, General Electric Company, Chicago.

Polarized Light—Dr. Kent Bracewell, Hamline University, St. Paul, Minnesota.

Interest, a Vital Approach to Physics—H. A. Oetting, East Alton-Wood River Community High School.

12:15 Noon

Luncheon for Chemistry and Physics Teachers.

Place: University Place Christian Church, Little Hall, 403 S. Wright St.

Speaker: Professor George Clark, University of Illinois, will discuss "Some Recent Advances in the Use of the X-Ray."

(Reservations should be sent in to Glenn Tilbury, Urbana High School, Urbana, Illinois, as early as possible, as the space is limited. Cost, 60 cents per plate.)

## PROGRAM OF ILLINOIS ASSOCIATION OF CHEMISTRY TEACHERS

**Meeting with Illinois State High School Conference**

2:00 p. m. Physics Building
Chairman: R. C. Soliday, Oak Park High School.

Developments in the Plastics Field—John Kenneth Carver, Plastics Division of the Monsanto Chemical Company.

The Work of the National Committee on Science Teaching—Harold Metcalf, Oak Park-River Forest Township High School.

Discussion of the Work of the National Committee on Science Teaching—Members of the sub-committees and other association members.

## PROGRAM OF ILLINOIS BIOLOGY TEACHERS' ASSOCIATION

**Meeting with Illinois State High School Conference, November 3, 1939**

9:00 a. m. Morning Session. 228 Natural History Building
Chairman: Grace L. Cook, Champaign High School

Recent Publications of the Natural History Survey — James S. Ayars, Editor, Natural History Survey, Urbana, Illinois.

Bird Migration (Illustrated)—Dr. S. C. Keudeigh, Zoology Department, University of Illinois.

Physiological Aspects of Exercise—Dr. F. R. Steggerda, Physiology Department, University of Illinois.

Cancer and Heredity—Dr. Maud Slye, Cancer Laboratory, University of Chicago.

12:00 Noon. Luncheon. WesleyFoundation, Green Street, Urbana.

2:00 p. m. Afternoon Session.

Business Session.

Laboratory Methods for the High School Teacher—Alfred Medendorp. Denoyer-Geppert Company, Chicago.

Laboratory Atmosphere—O. Ruth Spencer, Moline High School.

Biology Club Programs that I Have Found Interesting — Helen Ruth Gregory, Mount Vernon Township High School.

Visual Aids in Biology—Louis A. Astell, University High School, Urbana.

### RECENT DEVELOPMENTS

(Continued from page 9)

fama'e is now widely used as a flame-proofing agent for synthetic fabrics.

The recent announcement that the reaction product of ammonia and phosphorus pentoxide is available on the market as a flame-proofing agent and a humectant indicates that the chemical industry will undertake the development of phosphorus-nitrogen compounds. The compound nitrilophosphoric dichloride, $(PNCl_2)_3$, polymerizes under the action of heat to a rubber-like material. It is really and truly an inorganic plastic.

In all these cases ammonia is used as the raw material. These few examples indicate the trend of technical developments quite apart from such conventional and well-established products as ammonium salts, and the direct uses of ammonia in the petroleum industry, water purification, surface treatment of steel and as a fertilizer material. The ready availability and low price of ammonia dictates extension of its uses as well as investigation of related nitrogen compounds.

THE STATEMENT IS often made that the field of inorganic chemistry holds no promise, that this branch of chemistry has been completely exploited and that everything about it has been learned. Nothing is farther from the truth. The inorganic chemical industry has available for use raw materials which are obtainable in unlimited quantities — silica, phosphate rock, salt, sulfur, limestone, in addition to water and air. The technical evaluation of compounds of the elements silicon, phosphorus, nitrogen and sulfur is attractive and both process and product developments may be expected in these fields. Indeed, with the threat of possible exhaustion of coal, petroleum, and wood always under consideration, it is only logical that the chemical industry should turn to inorganic materials for the production of substitutes.

## MICROSCOPY IN BIOLOGY

(Continued from page 16)

that eight or nine of these expensive instruments are of no more value than two would be.

IN VIEW OF THE increased amount of leisure time that is now available to the ordinary layman, it seems that the high schools should provide many opportunities for their students to become acquainted with the vast array of interesting things about them. Such an acquaintance with the vast array of interesting things should serve to make the after school hours play of the child and the leisure hours pastime of the adult more than merely "killing time." The biology course already points the way to many fascinating hobbies. One phase of biological study in particular, that of microscopy, has been the pastime of many who could afford it for years. Today we are especially fortunate in that cheaper instruments of good quality are available Furthermore, it is possible to make tissue-slicing machines (microtomes) in our home workships at a cost within the reach of everyone. Kraus[1] tells how to make a "Precision Microtome for $1.00," but Hance[2] goes still farther and says that an amateur microtome can be built for thirty cents. These homemade "toys" can not take the place of the expensive microtomes used by research workers in the field of microscopy, of course, but they are perfectly satisfactory for the amateur and even for classwork in high school.

Since low cost instruments of good quality are so readily available it would seem that the high school student should be introduced to the world of interesting little things. Microscopy can be such a fascinating part of the biology course that it will lead many individuals into an adventurous avocation.

[1] Kraus, J. H. — Precision Microtome for $1.00—*Practical Microscopy,* I (1):30, July, 1934.

[2] Hance, R. T. — *General Microscopy and Histology,* p. 46, University of Pittsburgh Press, Pittsburgh, Pa., 1937.

## SCIENTIFIC METHOD

(Continued from page 15)

happens to be the tenth time and you are wrong, there is little consolation in the fact that the percentage was in your favor.

Finally, there is the last serious challenge to the scientific method. It comes from the humanist who says that the scientific method leads to a philosophy of pessimism. Is it not true, says he, that by the scientific method you have expanded the universe until man who was once and rightfully should be the center of the universe, shrinks to an infinitesimal creature whose actual existence is statistically improbable if not impossible, living as he does upon one of the meanest planets which revolves about one of its old burned out stars. There is probably not another planet in the whole Universe as we see it in which the fortuitous concurrence of favorable circumstance makes life as we know it possible. Even our near neighbors are uninhabitable. Mars, a freezing desert, and Jupiter, with its oceans of hydrocarbons filled with icebergs of frozen ammonia, would certainly be most inhospitable.

The answer to this is that you are looking at yourself through the wrong end of the telescope. The mind which comprehends the Universe has not been able to comprehend itself, but that is rather the way you would expect things to be: comprehension in the order of increasing difficulty. I am not one who argues that there is no sound when a tree falls in the forest and no one is there to hear it, but I do maintain that there is no such thing as a Bach Chorale unless someone hears it who has appreciation. So what significance has the Universe aside from the mind which comprehends it. I would like to quote the inscription upon Sir Isaac Newton's tomb in Westminster Abbey. It does not refer to the Deity or the Universe, but rendered in English it is: "Let mortals rejoice that so great a glory of the human mind has existed upon this earth."

## THE ENCEPHALOGRAPH

(Continued from page 13)

encephalograph. The electrocardiograph is a device which is used quite a bit in clinical diagnosis of heart ailments. It records the electrical impulses which are emitted from the heart and originate in the sinus node or as the doctors jokingly call it, the "pace-maker." Just how this electricity is generated is not exactly known, but it is suspected that it arises from biochemical reactions.

In construction, the electrocardiograph is comparatively simple. It consists of three main parts. They are: (1) the electrodes by which the electricity is taken from the body. These are attached to either arm at about the elbow. (2) The amplifier with which the signals are made stronger so that they may be recorded. (3) The recorder or indicator. In my experiment I used a cathode ray tube as an indicator.

The electroencephalograph is the brain writer part of the electrocardioencephalograph. It is a comparatively new development in the field of medical research. It picks up electrical signals which arise in the cortex of the brain, more commonly called the gray matter of the brain. Like that coming from the heart, this electricity probably arises from biochemical reactions.

In construction, the electroencephalograph is very similar to the electrocardiograph, the only differences being in the fact that the gain of the amplifier in the electroencephalograph is much higher than that of the electrocardiograph, and the placement of the electrodes. The electrodes of the encephalograph are placed on the upper forehead.

The person to be electrocardioencephalographed sits in a chair, preferably in a room which is shielded electromagnetically and electrostatically. I did not have such a room and consequently I was troubled quite a bit with extraneous hum. The electrodes are connected to the arms and to either side of the upper forehead.

The results of the experiment were, in my opinion, very favorable. Although the machine did not work on the first few trials, I found that by moving the

(Continued on page 28)

## HOW TO BOTANIZE

NOW AVAILABLE to teachers and students of biology is a new pamphlet, issued by the Illinois Natural History survey under the title, "Pleasure With Plants."

Written by Dr. L. R. Tehon, Botanist of the Natural History Survey staff, to promote more general interest in the plants of the state, the pamphlet deals with the mechanics of field botanizing, plant collecting, plant identification and herbarium building. This phase of botany, to which little attention is paid in the usual text or laboratory outline, is explained simply but in complete detail.

The pamphlet will prove valuable to many botany and biology teachers, enabling them to vitalize plant study through the development of individual and class projects relating to the local flora.

In the 32 beautifully printed and illustrated pages of this pamphlet, Dr. Tehon tells the person who would like to become acquainted with plants just how to go about it. He explains what botanizing is, suggests ways to botanize, and tells where and when to botanize. But, mostly, he tells how to botanize.

There are directions on how to collect plants for study and for the herbarium. Equipment necessary for the purpose is described. There are directions for the making of a plant press, the pressing and amounting of plant specimens, and the development of a personal or school herbarium. From the pamphlet one learns, also, how to keep a botanical notebook, what tools and instruments are needed for analyzing plant specimens, what botanical keys are and how to use them for the identification of strange plants, what the purpose of a scientific plant name is, how to label a specimen properly, and what books are most useful.

Of particular interest is the plan for a herbarium case, suitable for home or school, which can be built at small cost. Construction of such a case can be made a joint project between biology or botany, agriculture and manual training classes.

## NATIONAL COMMITTEE

(Continued from page 17)

Oak Park, Ill. (Social and Personal Needs)

As shown, these teachers represent most of the sub-committees. Through them, other teachers are invited to choose whatever sub-committee offers the most attractive field in which to co-operate with the National Committee.

IT IS PLANNED TO devote time at the Illinois High School Conference, Nov. 3d, 1939, to presentation and discussion of the work of this National Committee and the various sub-committees. Teachers will have an opportunity there to hear Mr. Metcalf and to talk to the various consultants present, and to discuss methods of co-operating. However, correspondence with any of these consultants is invited at once, so that information and directions may be distributed and the work actually started as soon as possible.

It is believed that every teacher of the sciences will welcome this opportunity for the following important reasons:

a. It actually permits the individual teacher to have an active and important part in a national educational study which is expected to make a significant contribution to the solution of our teaching problems.

b. It will provide guidance in a study of local problems of the individual teacher. Thus it will guide the teacher in an analysis of his own difficulties.

c. It will provide reports of the entire work, including sub-committees, for study by and for the benefit of each individual teacher.

d. It may reasonably be expected to have some influence upon the whole field of education, as teachers in other subject matter areas will doubtless be stimulated by the progress in science teaching.

It is therefore urgently suggested that every teacher who can possibly do so get in touch personally or by correspondence with one or more of the consultants listed above.

Ray C. Soliday

## KEEPING UP TO DATE

(Continued from page 5)

considered sufficient. These abstracts should be complete enough to convey the essential facts to the busy readers without additional reading. Obviously many readers will desire the original articles to become more familiar with the field.

Since the editorial board of The Science Teacher is composed of busy individuals, it is suggested that all readers may act os contributing editors, and as they encounter an article of particular interest to them, that they abstract it and pass it on so that others less fortunate may profit by it.

The editorial board of The Science Teacher welcomes the reaction of the subscribers to this suggestion. Please drop us a line stating your frank reaction to this idea.

Douglas G. Nicholson
University of Illinois

## STUDY OF INSECTS

(Continued from page 3)

The bibliography for the above paper consists of:


(A) Books:

(1) Metcalf and Flint — Destructive and Useful Insects.

(B) Pamphlets, Circular and Bulletins:

(1) Illinois Natural History Survey, Circular 473, "Fabric Insects."

(2) Illinois Natural History Survey, Circular 456, "Ants—How to Combat Them."

(3) Illinois Natural History Survery, Circular 257, "Control of Household Insects."

(4) U.S.D.A. Leaflet 144, "Cockroaches and Their Control."

(5) U. S. D. A. Farmers' Bulletin 627, "House Centipedes."

(6) University of Missouri, Bulletin 356, "Insect Pests of the Household."

### HOW MUCH MATHEMATICS?

(Continued from page 7)

chemical change, the mathematical equation is the precise statement of a law. In Boyle's and Charles' Laws we have a signal opportunity to teach that in high school chemistry.

Other problems which will be met with, in all probability are those of: vapor density and weight-volume calculations using the molar volume, measurement of solubility, measurements of concentration (moles per liter and normalities), and titrations.

This much mathematics would seem to be essential to almost any high school course. This much, at least, would point toward:

1. An appreciation of the science.
2. An understanding of scientific techniques and procedures
3. An introduction of the pupil to the way in which he too might use chemistry profitably in the investigation of the less difficult problems of home, school, community to which his eyes have been opened through his study of chemistry.

### THE ENCEPHALOGRAPH

(Continued from page 24)

electrodes around I could obtain the results desired. The signals were very weak. The cathode ray tube was of great help in detecting the weak currents.

Brain waves, I found, varied as to personality. The Alpha or smooth waves in the extrovert were from 30 to 75 per cent higher in frequency than those of the introvert. When the subject closed his eyes and thought of nothing, there appeared a very smooth regular wave. When told to concentrate on something such as an algebra problem, this wave vanished. The waves became long and irregular.

Normally the heart beat increased in normal conversation. In heated conversation it increased greatly.

# The Gist of It Seems to Be

## Abstracts and References

Experimentation is the method of improving education most likely to prove useful as shown by tested results. A limited but more thorough study than most, designed to check up on some of the wilder claims, assertions, slogans, and catchwords, shows surprisingly few significant differences in the actual results of even such divergent schools as the progressive and the conservative. Another study shows college biology students who have had high school biology being beaten by those who had no previous schooling at all in the biological sciences.—Otis W. Caldwell, "What Seems to be Ahead?", in Sch. Sci. & Math., June '39.

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Some studies based on the "Attitude Finder," also called the "Youth Expressionaire" give the following results: Those who have studied more science have different attitudes, opinions, interests, a greater respect for accuracy. They are about as superstitious but are more open-minded, have less prejudice, are more pacifistic. They show a greater preference for work in the various vocations and professions, are more internationally minded and tolerant in general. It is not shown whether this type of person elects science or science so moulds him.—P. P. DeWitt, "Attitudes Related to the Study of College Science" in Sch. Sci. and Math,, June '39. P. B. S.

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A physical science course has been developed for Lincoln School, very like that described and recommended in the Progressive Education Report, "Science in General Education." — H. Emmett Brown, "The Development of a Physical Science Course for the Lincoln School," in Sci. Ed., March, '39. P. B. S.

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The world crisis again focuses criticism on science. Is this not because present science teaching leaves whole populations of advanced nations uninfected with the true spirit of science? The most important effects, and perhaps the only lasting ones, of education, are the formation of good habits of body, mind and morals. Science teaching may be especially valuable in cultivating habits of accuracy, independence, critical judgment; ability to distinguish reason from emotion, truth from propaganda, evidence from ballyhoo; cultivation of humility and modesty in the face of the vast unknown, and recognition of the fact that all knowledge is incomplete and capable of improvement, etc., open-mindedness, tolerance, fair play, etc. These aims should come as a by-product of ordinary classroom or laboratory work if it is conducted in the spirit of real science, by teachers who themselves are exemplars of this spirit. Education is habit-formation rather than information; illumination rather than indoctrination; inspiration rather than compulsion. — Edwin G. Conklin, in "Science in the World Crisis,"—The American Biology Teacher, May 1939. P. B. S.

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Practical directions for building an incubator are given by S. E. Stoddard in "An Incubator for the Study of Living Embryos," — The American Biology Teacher, May 1939. P. B. S.

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Committee reports, professional articles, published courses of study, and the new texts indicate that since 1920 high school Chemistry organization has tended to

1. become more closely integrated with other high school subjects and place more emphasis on the social aspects of Chemistry.

2. become more topical with emphasis on individual units, interests, and projects.

3. become less influenced by authoritative committees and more influenced by scientific research and psychological theory.

Also there are some conflicting and branching tendencies:

4. to become more closely articulated with college Chemistry for efficiency.

5. to become less closely articulated with college Chemistry for the general students.

6. to become fused with Physics and perhaps Biology.

7. to become centered on the interests of the consumer. Theoretical points of view are developed in periodical articles and committee reports and gradually adopted in first the published courses of study and then in the new textbooks.—C. C. Hall in "Trends in the Organization of High School Chemistry Since 1920." Journal of Chemical Education, March 1939. P. B. S.

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Sixty-five pages of interesting material giving specific figures relative to spending the chemical dollar, taxes, significant trends, distribution of products, exports, imports, and production trends of important heavy chemicals. Also is included a series of graphs showing 1929, '31, '35, '37 and '39 production of 218 individual inorganic and organic chemicals from acetone and acetylene to zinc oxide and zinc sulfate. Comparisons are included using 1935 production as 100 percent.—"Facts and Figures of the American Chemical Industry," Chem. and Met. 46: 539-604, Sept. 1939. D. G. N.

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It has been demonstrated that sulfur monoxide has been prepared by the passage of a mixture of S vapor, $SO_2$, and air through a heated tube (700°): this reaction takes place to the extent of 1%. Z. Anorg. Chem. 211, 150 (1933). Likewise it has been shown that $3SO + N_2O_3 \rightleftarrows 3SO_2 + N_2$. In this manner it is quite easy to account for the loss of oxides of nitrogen encountered in industrial processes. (J. Chem. Soc. page 600 (1939). —"Loss of Nitric Oxide in the Chamber Process for the Manufacture of Sulfuric Acid," Science Progress 34, No. 133, July 1939. D. G. N.

## BOOK SHELF

Understanding Our Environment. John C. Hessler, President of James Millikin University, and Henry C. Shoudy, Teacher of Science, North High School, Syracuse, New York. Benjamin H. Sanborn and Company, Chicago, 1939. 661 pp. 219 figs.

Stimulating the student to put questions to nature and giving him aid in arriving at satisfactory answers appears to be one of the major objectives of the new text, Understanding Our Environment, by Hessler and Shoudy. In keeping with this idea the topics throughout are put in the form of questions, but they are very natural questions that any normal student of the ninth year level in school would want to know. According to the authors "Schools succeed as they stimulate the student to increase the number of 'whys' regarding his surroundings and experiences, provided that at the same time they point out to him how he may obtain adequate answers."

The text offers an exploratory course in the fields of science usually covered. It is inclusive enough to allow the teacher considerable choice in the areas studied, if these are covered intensively. When a less intensive study is desired, the text offers ample material, and a spread over a very wide field.

The book is organized into nineteen units, each of which is broken up into problems of logically related dearning elements. No unit is so long as to lose i's unity in the student's mind. The material is presented from the standpoint of its close relationship to the environment of the student. This is brought to one's attetion by the unit headings, such as, Why is heat important to man? How are weather and climate important? and What do we need to know about electricity? The practical values included may be seen from the inclusion of such topics as "How can we choose clothing for quality and utility?" and "How can we care for our clothing?" The units begin with preview questions and end with questions for discussion that are quite closely related to the students environment. Review questions, tests, and a supplementary reading list are also included.

From the standpoint of language the book is well-written. Sentence structure is simple, reasoning is clear, and the thought is easily grasped.

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Discovery of the Elements. Mary Elvira Weeks, Associate Professor of Chemistry, University of Kansas. Fourth edition, enlarged and revised. Journal of Chemical Education, Easton, Pennsylvania. 471 pp. 307 figs.

The Discovery of the Elements, by Mary Elvira Weeks, has from the first been warmly received by teachers of chemistry and by students alike. It presents the historical background of much useful chemical knowledge and links what otherwise might be dry facts with interesting personalities in such a way as to make the material quite intriguing. Through the introduction of personal letters of such men as Berzelius and Wohler, giving an insight into their aspirations and disappointments, their mental set and outlook, it stimulates, encouragegs, and leads its readers on to a more careful study of science.

In the fourth edition the book has been much enlarged through the addition of six entirely new chapters. One of these is on the work of Daniel Rutherford and his Services to Chemistry. The bibliographies, which were already of much length, have been extended. Some of the material has been rewritten to improve its presentation. The amount of revision given the book may be judged by the fact that the last edition contains one hundred more pages than the previous one.

In illustrations the book is well done. There are a wealth of pictures throughout. In many cases these have been rearranged. The predominating pictures are those of men who have made history in discovering the elements.

For those who take pleasure in coming into intimate contact with the lives of great people, The Discovery of the Elements will be found a treasure house. In the field of science, particularly chemistry, it is undoubtedly outstanding for its biographical sketches. It is particularly remarkable for its wealth of original material and personal letters of the men discussed, letters that pertained to the work that the men were attempting to pursue. It is a book that will be enjoyed alike by teacher and student, or by scientist and layman.

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Industrial Physics. L. Raymond Smith, Instructor in Industrial Physics, William Dickinson High School, Jersey City, New Jersey. McGraw-Hill Book Company, New York, 1939. Revised edition. 229 pp. 231 figs. $1.75 net.

Smith's Industrial Physics is limited to the field of elementary mechanics. But for those who want to include more of the practical applications of science in the physics course this book is quite desirable. It is adapted to the needs of vocational and evening classes interested in physics from the practical viewpoint. For these groups it would be particularly suitable as a text in elementary mechanics or in this phase of industrial physics. For the high school or academy it would be useful for supplementary work or for a reference.

Considerable attention is given to measuring instruments and their use. More space is given to forces and machines than is possible in the usual physics text. For example, equilibria of concurrent, non-concurrent, and parallel forces and their applications in ladders, cranes, trusses, and roof trusses are given. There are special chapters devoted to commercial and laboratory structures, elasticity, friction, practical study of machines, mechanical transmission of power.

A special attempt is made to relate the principles of physics to the every day life of the student. The best chapters from this standpoint are on friction, mechanical transmission of power, and fluids. Many drawings and pictures of machines are used. Ample questions and problems are included at the end of chapters to give a review of the principles presented.

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The Annual Convention of the Central Association of Science and Mathematics Teachers will be held at the Morrison Hotel, Chicago, Illinois on November 24th and 25th, 1939. Special attention is being given to programs designed for elementary school, junior and senior high school, and junior college teachers of science and mathematics.